

THE WEATHER AND CIRCULATION OF NOVEMBER 1960¹

Another November with a Mid-Month Reversal

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1. HIGHLIGHTS

Temperatures averaged unseasonably mild throughout most of the United States during November 1960, continuing the warm regime which dominated the country during most of the fall season. This was in sharp contrast to the cold November and fall season of 1959 [1]. In the latter part of the month temperatures in many sections east of the Rockies rose to record high levels for so late in the year. At Rapid City, S. Dak., the average temperature on the 25th was 32° F. above normal, and the maximum was 75° F.

Precipitation totals were in excess of normal in the western States, where many places experienced one of the wettest Novembers on record. In Nevada reservoirs were beginning to refill after two years of drought. In contrast to the West, some large areas east of the Rockies had one of their driest Novembers, particularly the Central Plains and extreme southern Rockies, as well as much of the eastern and southeastern parts of the country.

A marked change in circulation near mid-month was reflected in intensification of storminess over the country in the second half of the month, particularly from the Great Lakes westward. A rapidly deepening storm swept across the Great Lakes on the 15th and 16th, accompanied by high winds, thunder, hail, and tornadoes. In the Far West the weather was quite stormy in the last part of the month with almost daily precipitation in the Pacific Northwest. Heaviest amounts were reported from western Oregon, where flooding caused considerable damage and required evacuation along tributaries of the Willamette river.

Near the month's end, a storm moved out of Nevada on the 27th and swept across the northern Plains, intensifying to blizzard proportions on the 27th and 28th in juxtaposition with a strong crescent-shaped continental-polar High centered over western Canada. High winds (e.g., a record for November of 68 m.p.h. at Duluth, Minn.) and heavy snows in north central areas brought the coldest weather of the season to many places east of the Rockies. For example, Havre, Mont., reported a

daily temperature departure from normal of -34° F. on the 28th and Huron, S. Dak., -31° on the 30th.

2. AVERAGE MONTHLY CIRCULATION

The average circulation at 700 mb. for November 1960 (fig. 1) was of the high-index type; i.e., negative height departures from normal dominated the higher latitudes, while positive departures were general at lower latitudes. The only significant exception was the area of blocking and positive height departures over Greenland and the Norwegian Sea.

The most anomalous feature of this average circulation was the strong negative height anomaly near Ireland. This center, together with the blocking to its north, had also been a feature of the previous month's pattern [2] when it was displaced slightly southeastward.

At sea level, the monthly average pattern (not shown) contained a deep cyclonic center as much as 14 mb. below normal west of Ireland, close to the -450-ft. center of height departure at 700 mb. shown in figure 1. This center of action was a manifestation of persistent daily storminess during the month. For example, systems as deep as 960 mb. were observed on 10 days, while storms as deep as 975 mb. were observed on 25 days during the month somewhere in the North Atlantic.

In November there was considerable shearing of the troughs which had been generally of the full-latitude type in October. This was reflected (fig. 1) in troughs at high latitudes superimposed over low-latitude ridges, especially in the Atlantic and Pacific. As a result the zonal index, a measure of the strength of the mid-latitude westerlies averaged over the Western Hemisphere at 700 mb., increased from 9.7 m.p.s. (0.2 m.p.s. above normal) in October to 12.4 m.p.s. (1.9 m.p.s. above normal) in November. The greatest strengthening of the westerlies occurred in the eastern Atlantic, but increases occurred elsewhere in the Western Hemisphere as height falls (relative to normal) at high latitudes were superimposed on rises at lower latitudes, as shown in figure 2.

The height anomaly difference pattern between October and November over North America (fig. 2) is also of

¹ Articles describing the weather of December 1960 and January and February 1961 will appear in the March, April, and May, 1961 issues, respectively, of the *Monthly Weather Review*.

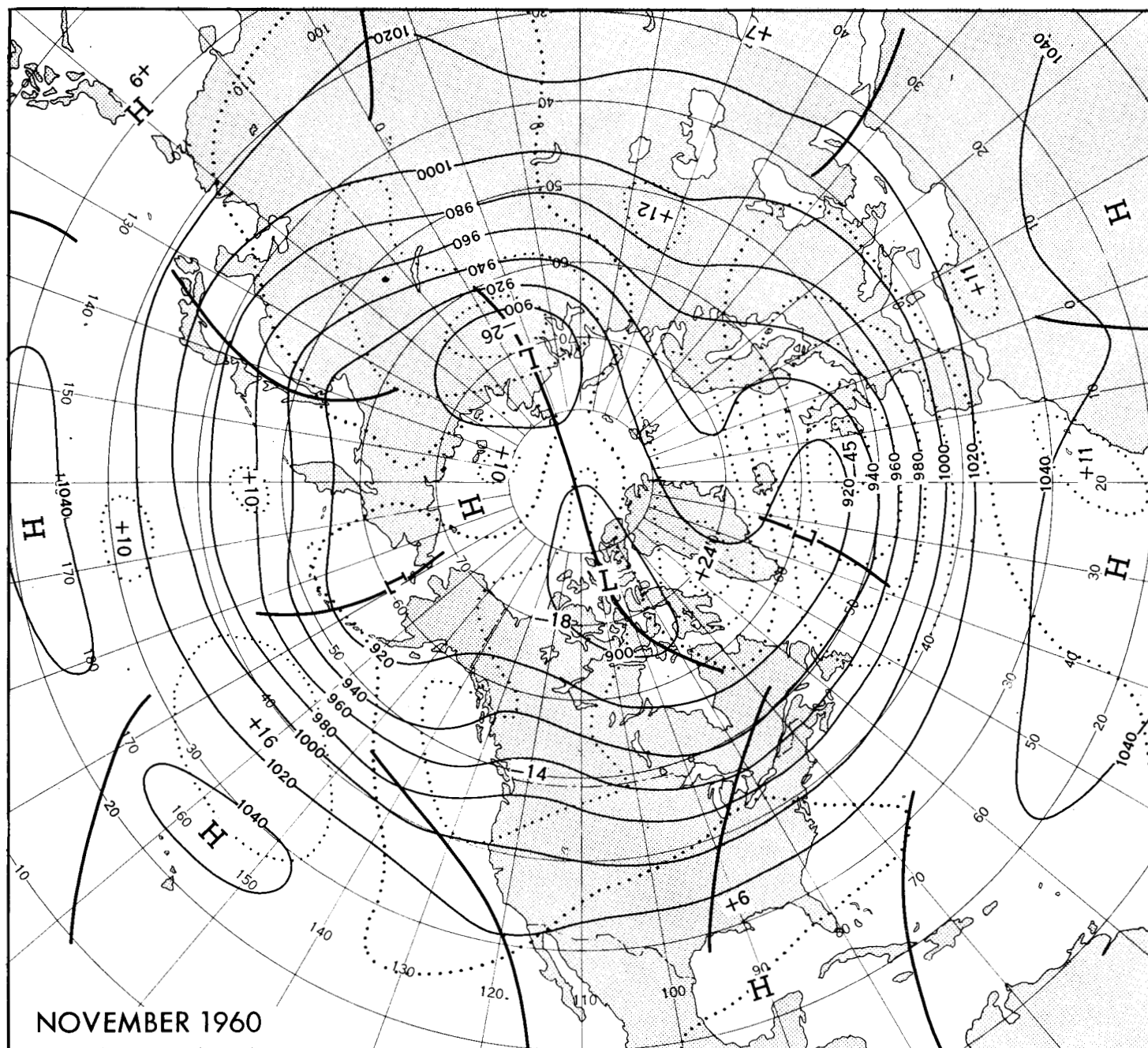


FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for November 1960. High index was the outstanding feature of the circulation with negative departures at high latitudes and positive departures at lower latitudes.

interest in connection with the changes of weather from October to November. The general trend over the United States shown in this pattern, i.e., falls in the West and rises in the East, was toward more southerly (or less northerly) components of the average flow. This favored warmer temperatures, relative to normal, than the previous month, and increased precipitation. A computation of the temperature anomaly class changes for 100 stations distributed throughout the contiguous United States

showed that 41 percent warmed from 1 to 2 classes, while 44 percent remained in the same class (out of five). This represents unusually high persistence from October to November. A similar abnormality occurred last November [1], when 85 percent of the country did not change by more than one class. For precipitation, the northern and western sections reported heavier precipitation than in the previous month, while most of the remainder of the country became drier, except in the Kentucky-Tennessee area.

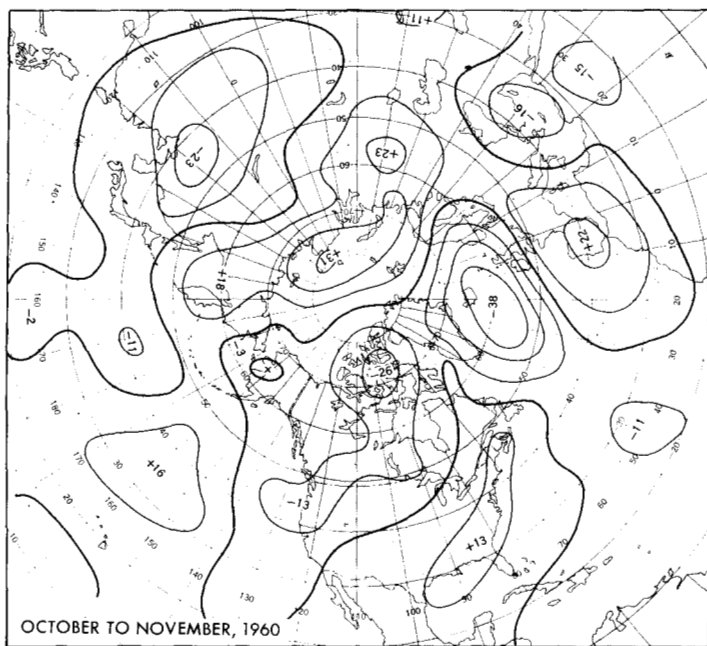


FIGURE 2.—Difference (in tens of feet) between the mean monthly 700-mb. height departures from normal of October and November 1960. Falls in the Pacific Northwest and rises in the southeastern United States produced anomalous southerly or southwesterly components of the average flow over most of the country and general warming, relative to normal, from October.

3. AVERAGE NOVEMBER WEATHER

Surface temperatures during November averaged up to 4° F. above normal over most of the contiguous United States and Hawaii, but below normal over most of California and Alaska (fig. 3). The generally mild weather can be explained by the prevalence of anomalous southwesterly components of average flow, as shown by the height departure pattern in figure 1.

Precipitation (fig. 3) averaged heavier than normal in the western United States where many stations reported one of the snowiest Novembers on record. The wetness in the West was related to the deeper than normal trough off the Pacific Coast of North America and to frequent, and at times intense, daily storminess which propagated inland periodically from this trough. Very heavy precipitation in southern California and Nevada occurred early in the month in association with a strong cutoff Low aloft over this area. Although precipitation in the Mississippi Valley was mostly less than normal, nevertheless it stands out in figure 3 in contrast to the dryness in the Plains and in the East. This precipitation was associated with a mean trough in the area (fig. 1) and was produced by daily troughs of large amplitude crossing this region at about weekly intervals, on about November 1, 9, 15, 23, and 28. The troughs of the 1st, 15th, and 28th were associated with deep surface systems

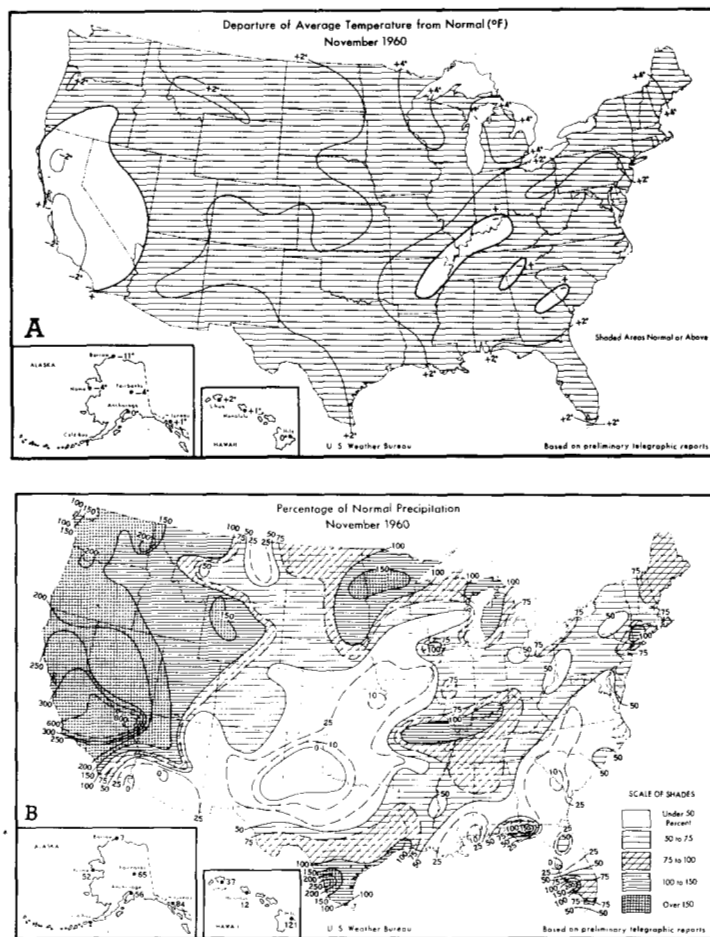


FIGURE 3.—(A) Temperature departure from normal (° F.) for November 1960. (B) Percentage of normal precipitation for November 1960. (From [4].)

4. THE MID-MONTH REVERSAL

Although this November exhibited more than normal persistence from the previous month, especially in temperature, the circulation within the month was characterized by considerable variability. The intra-monthly variability is best portrayed by the patterns of average circulation and temperature for the two half-months, shown in figures 4 and 5, and by the height differences between the first and last halves of the month at 700 mb., shown in figure 6.

In the first half-month (fig. 4A), a stronger than normal ridge along the west coast of Canada and a deeper than normal trough over the Great Lakes facilitated the deployment of colder than normal polar air from Canada southward over the United States. As a result temperatures averaged below normal (fig. 4B) over most of the country, except for parts of the Southwest. The coldest region in this period, relative to normal, was the Kentucky-Tennessee area, where temperatures are known to be inversely correlated with height departures in western Canada.

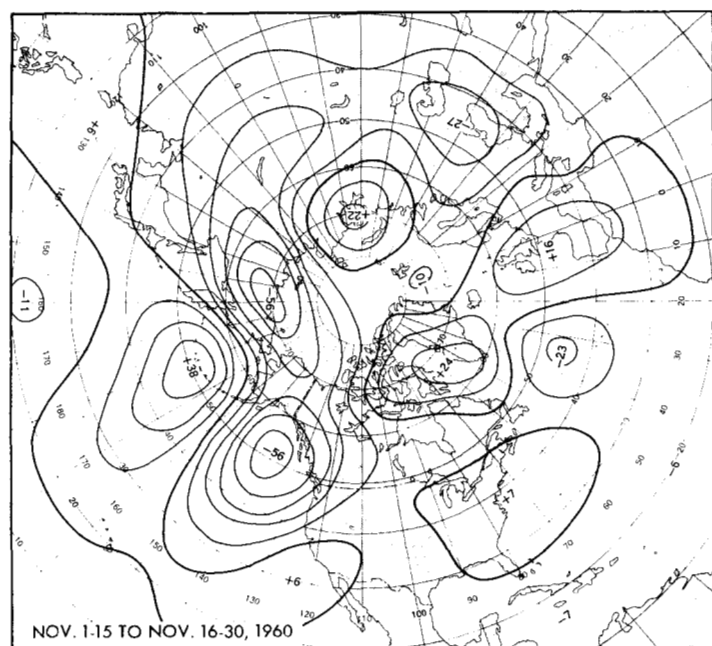


FIGURE 6.—Mean 700-mb. height changes (tens of feet) between first and last halves of November 1960 (figs. 4A and 5A). Height rises in the Central Pacific and falls off the west coast of North America produced a marked change in the mean flow.

rapidly after the minimum in late September, reaching their maximum value of 7.0 m.p.s. in early November. The temperate westerlies reached their maximum of 14.6 m.p.s. (4.0 m.p.s. above normal) almost two weeks later. This was the second highest November index since 1945, and was exceeded only by 14.8 m.p.s. in the period November 13–17, 1948. As the normal index curves suggest, the maximum yearly values usually occur later in the year, generally late December or early January. The development of an abnormally strong maximum in the westerlies at mid-latitude frequently signals the beginning of a long decline associated with the winter index cycle. In this case, figure 7 shows a sharp drop in the temperate westerlies subsequent to the November maximum, with the decline still in progress as of mid-December. The abnormally early date of the maximum and subsequent decline this year suggests that the kind of weather normally associated with the winter season commenced early.

As was observed with the maxima in December 1959 and again in April 1960 just prior to major reversals in the trend of the indices [3], the index maximum at mid-latitudes this month lagged the subtropical maximum by about two weeks. In addition it was simultaneously associated with increased positive values in the subtropics of latitudinally averaged height anomalies in the western zone of this hemisphere (not shown). By way of comparison, these positive anomaly averages were as follows: 130 ft. in December 1959 at 35° N., 100 ft. in April 1960 at 30° N., and 90 ft. in November 1960 at 30° N. Maxima of average positive anomalies at these latitudes are, of

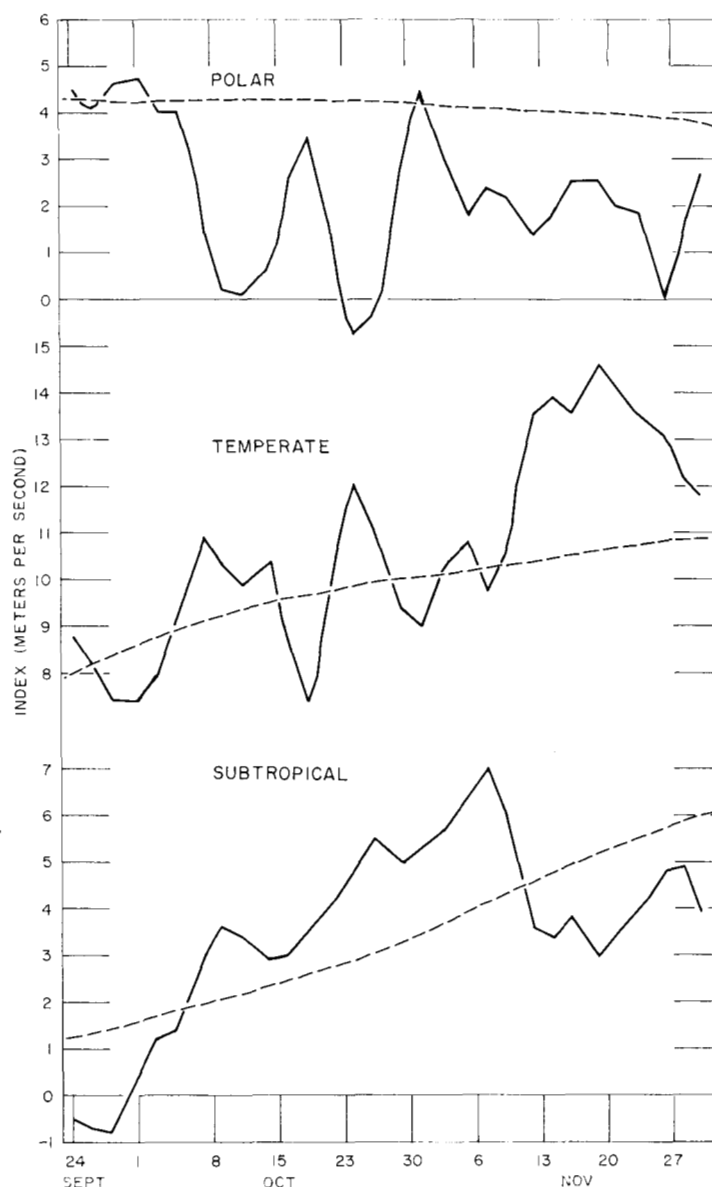


FIGURE 7.—Time variation of 5-day mean 700-mb. indices in meters per second for the western zone of the Northern Hemisphere (0–180° W.). Subtropical index applies between latitudes 20° N. and 35° N., temperate index between 35° N. and 55° N., and polar index between 55° N. and 70° N. Values are for 5-day periods ending on dates indicated. "Normal" indices (dashed lines) averaged from maps of [5].

course, associated with minima of the subtropical westerly index. Thus again we have the suggestion that a minimum in the subtropical index, associated with a positive anomaly maximum in the subtropics, of about 100 ft., may be a signal for a major reversal in the index cycle. Furthermore, as occurred in late December 1959, April 1960, and this month also, the index reversal is likely to be accompanied by a major upheaval in long-wave and weather patterns, manifested initially at the surface by violent storm activity traversing the country from southwest to northeast.

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